a first metal layer deposited on the first side of the semiconductor layer; and

a second metal layer deposited on the second side of the semiconductor layer.

2. The diode of claim **1**, wherein the thickness of the semiconductor layer is comparable to or less than the mean free path of the charge carrier emitted into the semiconductor layer.

3. The diode of claim **1**, wherein the diode has a cut-off frequency exceeding 100 THz.

4. The diode of claim **1**, wherein the diode has a cut-off frequency exceeding 1000 THz.

5. The diode of claim **1**, wherein the first metal layer and the second metal layer comprise a same metal, and an interface of the semiconductor layer is degenerately doped for creation of an ohmic contact.

6. The diode of claim **1**, wherein the first metal layer comprises a first metal, the second metal layer comprises a second metal, and the first metal and the second metal are different metals.

7. The diode of claim **6**, wherein an interface of the semiconductor layer is degenerately doped for creation of an ohmic contact.

8. The diode of claim **1**, wherein the semiconductor layer comprises one or more of a crystalline semiconductor and a polycrystalline semiconductor.

9. The diode of claim **8**, wherein the semiconductor layer comprises one or more of silicon (Si), germanium (Ge), silicon germanium (SiGe), aluminum antimonide (AlSb), gallium antimonide (GaSb), gallium arsenide (GaAs), indium antimonide (InSb), indium arsenide (InAs), indium gallium arsenide (InGaAs), gallium nitride (GaN), indium phosphide (InP), cadmium selenide (CdSe), cadmium telluride (CdTe), cadmium sulfide (CdS), zinc selenide (ZnSe), zinc telluride (ZnTe), zinc sulfide (ZnS), zinc oxide (ZnO), titanium oxide (TiO_2), lead sulfide (PbS), and lead telluride (PbTe).

10. The diode of claim **1**, wherein the first metal layer and the second metal layer each comprise at least one metal selected from the group consisting of silver (Ag), aluminum (Al), gold (Au), cobalt (Co), chromium (Cr), copper (Cu), gadolinium (Gd), hafnium (Hf), indium (In), iridium (Ir), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), palladium (Pd), platinum (Pt), rhodium (Rh), tantalum (Ta), titanium (Ti), tungsten (W), and zinc (Zn).

11. The diode of claim **1**, wherein the diode comprises a metal-semiconductor-metal heterojunction diode (MSM diode), and wherein the MSM diode further comprises:

a heterojunction between the semiconductor layer and one or more of the first metal layer and the second metal layer.

12. A method for fabricating a diode, comprising:

providing a semiconductor having a first side and a second side opposite the first side, the semiconductor having a thickness between the first side and the second side, the thickness being based on a mean free path of a charge carrier emitted into the semiconductor;

depositing a first metal on the first side of the semiconductor; and

depositing a second metal on the second side of the semiconductor.

13. The method of claim **12**, wherein the thickness of the semiconductor is comparable to or less than the mean free path of the charge carrier emitted into the semiconductor.

14. The method of claim **12**, wherein obtaining the semiconductor comprises:

obtaining a substrate of layered materials that includes a layer comprising the semiconductor and one or more other layers comprising at least one material that is different from the semiconductor;

bonding the first side of the semiconductor to a carrier wafer to position the first metal between the semiconductor and the carrier wafer; and

removing the one or more other layers to expose the second side of the semiconductor.

15. The method of claim **14**, wherein:

depositing the first metal on the first side of the semiconductor comprises patterning the first side of the semiconductor; and

bonding the first side of the semiconductor to the carrier wafer comprises bonding the first side of the semiconductor to the carrier wafer using an insulating adhesive.

16. The method of claim **14**, wherein:

depositing the first metal on the first side of the semiconductor comprises depositing the first metal directly onto the first side of the semiconductor as a uniform metal film; and

bonding the first side of the semiconductor to the carrier wafer comprises bonding the first side of the semiconductor to the carrier wafer using an adhesive.

17. The method of claim **12**, wherein the first metal and the second metal are of a same metal, and the method further comprises:

degenerate doping of a surface of the semiconductor layer for creation of an ohmic contact.

18. The method of claim **12**, wherein the first metal and the second metal are different metals.

19. The method of claim **18**, further comprising:

degenerate doping of a surface of the semiconductor layer for creation of an ohmic contact.

20. The method of claim **12**, wherein the semiconductor comprises one or more of a crystalline semiconductor and a polycrystalline semiconductor.

21. The method of claim **20**, wherein the semiconductor comprises one or more of silicon (Si), germanium (Ge), silicon germanium (SiGe), aluminum antimonide (AlSb), gallium antimonide (GaSb), gallium arsenide (GaAs), indium antimonide (InSb), indium arsenide (InAs), indium gallium arsenide (InGaAs), gallium nitride (GaN), indium phosphide (InP), cadmium selenide (CdSe), cadmium telluride (CdTe), cadmium sulfide (CdS), zinc selenide (ZnSe), zinc telluride (ZnTe), zinc sulfide (ZnS), zinc oxide (ZnO), titanium oxide (TiO_2), lead sulfide (PbS), and lead telluride (PbTe).

22. The method of claim **12**, wherein the first metal and the second metal each comprise at least one metal selected from the group consisting of silver (Ag), aluminum (Al), gold (Au), cobalt (Co), chromium (Cr), copper (Cu), gadolinium (Gd), hafnium (Hf), indium (In), iridium (Ir), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), palladium (Pd), platinum (Pt), rhodium (Rh), tantalum (Ta), titanium (Ti), tungsten (W), and zinc (Zn).

23. A p-type metal-semiconductor-metal heterojunction diode (MSM diode), comprising:

a silicon layer having a first side and a second side opposite the first side, a surface of the first side being doped with boron at a surface concentration of 1×10^{20} cm^{-3}, the